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NEW FACTS CONCERNING THE WHITE-PINE BLISTER RUST.[1]

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INTRODUCTION.

In a recent publication[2] the writer gave the latest information regarding the white-pine blister rust up to the spring of 1913. The past season has brought forth several additional developments, which are of great importance.

THE SITUATION AT GENEVA.

Since 1906, when Stewart first discovered the presence of *Cronartium ribicola* upon Ribes at Geneva, N. Y., the disease has been found there in several different years.[3] This occurred in spite of the total destruction of the Ribes found affected in 1906 and the apparent absence of the æcial stage of the fungus on the neighboring white pines.[3] In the spring of 1913 the New York State department of agriculture took up the matter, and a special effort was made to locate and examine every white-pine tree within the diseased area, with the result that two trees about 15 years old were found by Inspector Maney bearing the fruiting bodies of the fungus. They were promptly destroyed. These evidently had been diseased for a long time, probably since they were 3 or 4 years old. No definite

[1] This paper is intended to supplement the previous publication, Bureau of Plant Industry Bulletin 206, entitled "The Blister Rust of White Pine." It is, therefore, as brief as possible, and care has been taken not to duplicate statements made in that publication. These two bulletins are necessary in order to secure complete information regarding this disease.

[2] Spaulding, Perley. The present status of the white-pine blister rust. *In* U. S. Dept. Agr., Bur. Plant Indus. Circ. 129, p. 9–20, 6 fig. 1913.

[3] Stewart, F. C. Pine blister rust and currant felt rust. *In* West. N. Y. Hort. Soc. Proc. 58th Ann. Meeting, p. 122–124. 1912.

Stewart, F. C., and Rankin, W. H. Can Cronartium ribicola overwinter on the currant? *In* Phytopathology, v. 4, no. 1, p. 43. 1914.

Jordan, W. H. Director's report for 1906. N. Y. State Agr. Exp. Sta. Bul. 284, p. 341–342. 1906. Director's report for 1912. N. Y. State Agr. Exp. Sta. Bul. 356, p. 559. 1912.

NOTE.—This paper contains additional information concerning the white-pine blister rust that was collected during the season of 1913. It is of interest to foresters, tree experts, nurserymen, and owners of ornamental and forest plantations of 5-leaved pines.

information concerning their origin could be obtained, but it is believed that they were imported when 3 or 4 years old, that the disease came with them, and that they have been serving ever since as a center of infection each season for the Ribes in that vicinity. During the season of 1913 the disease appeared on but few Ribes bushes near the two trees above mentioned. The pines of the vicinity are to be held in quarantine and inspected each spring. In spite of the recent pessimistic opinion of those most directly concerned in the matter,[1] there is every reason to believe that the disease will soon be eradicated at this point, now that the center of infection is finally located. The conclusion that "complete eradication of the disease is no longer possible" is apparently meant to apply to the entire country and is based on the fact that blister rust was established at Geneva and the supposition that it was established in other places in New York, Massachusetts, and Connecticut. Now that the disease is well in hand in the Geneva area (the most dangerous one known at that time in the entire country[2]), there seems to be no sufficient reason for giving up the fight against as dangerous a disease as this promises to become if unchecked. This is especially true in view of earlier statements as to the seriousness of this disease.[3]

NEW OUTBREAKS.

Early in July the writer received specimens of white pine affected with blister rust from a point in northern Vermont which had not been previously known as harboring the disease. Inquiry showed that it was present upon native trees in that vicinity, this being the first known instance in this country. A visit was immediately made to determine the facts in the case, and the disease was found in the ornamental plantings of a large private estate. The original source of infection is unknown. It is quite possible that a few imported white-pine trees were obtained years ago, although it is definitely known that most of the trees in the vicinity are native and grew in the near-by woods. At any rate, the disease has been in some of the trees about 10 years, judging from the location of the cankers and their general appearance. Of the total number of white-pine trees in that vicinity, about 150 in all, more than 50 were found to be visibly affected by the disease. How many may later develop blister rust is, of course, unknown, but probably 5 or 10 per cent will do so. Already about 33⅓ per cent have it, which should be sufficient to convince the occasional skeptic that this will be a serious disease[4] if allowed to run its course in this country.

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[1] Stewart, F. C., and Rankin, W. H. Cronartium ribicola and the proscription of Ribes nigrum. (Abstract.) *In* Phytopathology, v. 3, no. 1, p. 73. 1913.

[2] Stewart, F. C., loc. cit.

[3] Stewart, F. C., loc. cit.; Jordan, W. H., loc. cit., 1912.

[4] Clinton, G. P. Notes on plant diseases of Connecticut. *In* Conn. Agr. Exp. Sta. Rpt., 1909–10, p. 733. 1911.

The disease had evidently reached a stage at this place where its future spread would be much more rapid than it has been in the past. About 100 feet from the apparent original center of infection was a single black-currant bush (*Ribes nigrum*),[1] some 50 to 75 red-currant bushes (*Ribes vulgare*), and about 30 gooseberry bushes (*Ribes grossularia*). The leaves of the black currant were covered with telia and uredinia of *Cronartium ribicola*, but only a very few sori were found on the red currants and none on the gooseberry leaves. Evidently the conditions have been extremely favorable for the propagation and spread of the fungus ever since the Ribes were set in that locality. All of the Ribes have been removed and destroyed, and the diseased trees and parts of trees are being cut out and destroyed.

Late in the fall of 1912 the writer received a specimen of blister rust on leaves of Ribes from Ipswich, Mass. In the spring of 1913 two small white pines which bore fruiting bodies of the fungus were found by the State nursery inspector near the diseased Ribes bushes. These were destroyed, and it was believed that the disease had been eradicated. It appeared later, however, about half a mile away, on leaves of *Ribes nigrum* and of *Ribes vulgare* of the variety Red Cross. The abundance of the fungus led the writer to suspect the center of infection to be near by. An examination promptly revealed evidences of the disease on neighboring white pines of about 10 and 18 years of age. Steps are being taken to remove the diseased trees and branches and also the black currants.

In 1913 Clinton [2] reported an outbreak of this fungus on the leaves of black currants near Meriden, Conn., late in 1912. He examined the vicinity, but could find no infected white pines in that locality. The origin of this outbreak is still unknown, and for this reason the situation is perhaps more dangerous than that in any other locality where the disease is now known to occur.

SERIOUSNESS OF THE DISEASE.

In the Vermont locality mentioned one large white pine about 2 feet in diameter and quite mature from the lumberman's standpoint was found to have the disease scattered throughout the top. Branches of all sizes up to 4 inches in diameter were thus affected. From the condition of this tree it was very easy to understand how a large tree may be killed by very severe attacks of this fungus, since it is a mere matter of time before an attacked branch or tree trunk is killed above the point of infection. One tree about 20 years of age, which had been infected in the trunk about 10 feet from the ground,

[1] The three Ribes mentioned are cultivated species which have been introduced into this country from Europe. The last (*Ribes grossularia*) is usually placed in a different subgenus than are the two first; by some authors it is placed in a separate genus.

[2] Clinton, G. P. Notes on plant diseases of Connecticut. *In* Conn. Agr. Exp. Sta. Rpt., 1912, p. 347–348. 1913.

had its top entirely dead above that point. Numerous small branches were found on other trees in a similar condition. A number of other trees of the same age apparently have been killed in a similar way, as they have been dying for years and have had to be removed, one or two at a time. While it takes a long time for the destructiveness of this disease to reach its climax in any given locality, there can be no doubt that if it finally becomes established and generally distributed in our forests it will be the worst enemy the white pine has here, as is stated to be the case in certain European countries.[1] It has become so thoroughly established in Europe that there is no hope of eradicating it there, but there is yet time to suppress it here if the danger is once generally realized. Even with conditions as they are in Europe, one of the most prominent plant pathologists of Germany recommends the energetic fighting of this disease.[2] If such action is advisable in Europe, even more drastic action is certainly proper in this country.

CAN THIS DISEASE WINTER OVER ON RIBES?

Late in 1912 F. C. Stewart asked the writer to take part in a cooperative experiment to try to determine whether this disease can winter over on dormant Ribes stock and thus be carried from one place to another in stock which has previously been diseased. Two hundred 2-year-old *Ribes nigrum* plants which had been heavily rusted by *Cronartium ribicola* in the late summer and early fall of 1912 were sent to the writer at Washington, D. C., about December 1. They were promptly heeled in out of doors until February 1, when, according to agreement, they were potted and brought into the greenhouse. They started quickly and made a very vigorous growth. They were examined several times for the presence of *Cronartium ribicola,* but none was found. The experiment was concluded about May 20 because of the writer's absence after that date. Parallel tests were made at Geneva and Ithaca, N. Y., Lafayette, Ind., Amherst, Mass., and New Haven, Conn., 300 plants being used.[3] The results were entirely negative. The evidence furnished by the

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[1] Bos, J. Ritzema. Phytopathologisch laboratorium Willie Commelin Scholten. Verslag over de inlichtingen gegeven in 1900. *In* Landbouwk. Tijdschr., jaar 9, p. 77. 1901.

Fisher, W. R. Experimental plantations at Coopers Hill. *In* Quart. Jour. Forest., v. 3, no. 3, p. 229. 1909.

Fron, Georges. Nouvelles observations sur quelques maladies des jeunes plants de Conifères. *In* Bul. Soc. Mycol. France, t. 27, no. 4, p. 476–481. 1911.

Lind, Jens. Danish fungi as represented in the herbarium of E. Rostrup, p. 281–283. Copenhagen, 1913

Neger, F. W. Die Nadelhölzer . . . p. 110–111. Leipzig, 1907.

Somerville, W. Peridermium strobi, the blister of Weymouth pine. *In* Quart. Jour. Forest., v. 3, no. 3, p. 232–236. 1909.

Watson, J. G. The Woburn forests. *In* Gard. Chron., s. 3, v. 52, p. 422. 1912.

[2] Tubeuf, Carl von. Über die Verbreitung von Baumkrankheiten beim Pflanzenhandel. *In* Mitt. Deut. Dendrol. Gesell., p. 156–163, 1904.

[3] Stewart, F. C., and Rankin, W. H. Can Cronartium ribicola overwinter on the currant? *In* Phytopathology, v. 4, no. 1, p. 43. 1914.

natural occurrence of the disease shows that dormant Ribes stock does not harbor the fungus. But all the evidence is negative (except that mentioned earlier by the writer) [1] and is subject to certain limitations, as is all negative evidence, when general conclusions are drawn from it. That is, it does not effectually dispose of possible rare exceptions, which may occur only once in thousands of cases. The practical conclusion is that Ribes plants do not carry the fungus over winter and that an outbreak of this disease on Ribes is to be attributed to the presence of neighboring white pines which have the blister rust. Hence, when the disease is found on Ribes leaves a special effort should be made to locate and destroy infected trees.[2] Ewert [3] has recently published a paper showing that thorough spraying with Bordeaux mixture, with special care to cover the lower surface of the leaves, will almost completely control this fungus upon *Ribes nigrum*. It is suggested that in the future when diseased pine trees are found early in the summer, any Ribes in the vicinity be promptly sprayed on both sides of the leaves, in order to reduce the resulting infections and the outbreak of the uredo stage. Spraying should not be resorted to except as a temporary expedient, as just indicated.

About May 15, 1913, several plants of *Ribes nigrum* were isolated and an attempt was made to inoculate them with telial material furnished by Stewart which had been kept out of doors all winter. This attempt was unsuccessful, as was also a similar one made by the writer in 1912 with fresh teliospores.

CULTIVATED VERSUS WILD RIBES.

A statement has been made implying that the cultivated species of Ribes are not dangerous factors in connection with this disease.[4] All of our experience in this country shows that the contrary is true. In no known case has the disease been discovered on native wild species of Ribes, while it has been found in a number of cases on the cultivated species of *Ribes nigrum* and *Ribes vulgare*. The evidence shows that our native wild *Ribes cynosbati* and *Ribes prostratum* are resistant to the fungus, while *Ribes nigrum* is exceedingly susceptible, and some varieties of *Ribes vulgare* are quite susceptible. The variety Red Cross has been found in one instance to be seriously diseased. *Ribes grossularia* has been immune. The cultivated Ribes are much

[1] Spaulding, Perley. Notes upon Cronartium ribicola. *In* Science, n. s., v. 35, no. 891, p. 146–147. 1912.
——— The present status of the white-pine blister rust. *In* U. S. Dept. Agr., Bur. Plant Indus. Circ. 129, p. 17. 1913.

[2] Spaulding, Perley. Notes on the white-pine blister rust. (Abstract.) *In* Phytopathology, v. 4, no. 1, p. 41–42. 1914.

[3] Ewert, R. Erfolgreiche Bekämpfung des Cronartium-Rostes auf der schwarzen Johannisbeere. *In* Ztschr. Pflanzenkrank., Bd. 23, Heft 8, p. 463–476, 2 fig. 1913.

[4] Clinton, G. P. Notes on plant diseases of Connecticut. *In* Conn. Agr. Exp. Sta. Rpt., 1909–10, p. 732 1911.

more dangerous than are the native wild plants, because many white-pine plantations are made on deserted farms. In such places the former garden currants persist for years, and the inspector often finds them in the midst of a plantation of imported pines. Moreover, nurserymen often keep stocks of white pines and Ribes in proximity to each other, which is dangerous if either has the disease. These facts do not mean that wild species of Ribes can be disregarded, but that both wild and cultivated species must be considered when control measures are undertaken.

PINUS EXCELSA A HOST.

In a recent publication Lind[1] mentions the Himalayan pine (*Pinus excelsa*) as a known host of the white-pine blister rust in Denmark. The writer is informed that the disease was found in 1913 upon young trees of *Pinus excelsa* in Massachusetts. Unfortunately, no specimens of it were saved, but there seems to be no doubt that *Pinus excelsa* is a host of this fungus and is liable to be affected by it in this country. This is the first time that the white-pine blister rust has been found here on any other species of pine than *Pinus strobus*.

AGE OF DISEASED WHITE-PINE TREES.

White-pine trees from 3 to about 75 years old having the blister rust have been seen. From 3 to 15 years the series was almost uninterrupted; then the ages were approximately 18, 20, 25, and 75 years. The trees of 25 and 75 years were diseased on the branches and not on the main stem, but below 25 nearly all have been affected on the main stem. The evidence seems to show that this disease has been present on small numbers of imported pine trees in this country since 1888, and perhaps longer.[2]

DISTRIBUTION OF SPORES OF CRONARTIUM RIBICOLA.

In 1912 the writer made some observations on the distribution of the spores of *Cronartium comptoniae* from *Pinus rigida* to *Comptonia asplenfolia*.[3] The æciospores are so similar in size and shape to those of the blister rust on white pine that it seems probable that one would be distributed as far as the other under the same conditions. It was found that the æciospores of *Cronartium comptoniae* were blown about 30 feet from their point of origin. This led the writer to suspect that the æciospores of the white-pine blister rust would also be blown relatively short distances. Such has been the case in all those

[1] Lind, Jens. Danish fungi as represented in the herbarium of E. Rostrup, p. 281–283. Copenhagen, 1913.

[2] Spaulding, Perley. The blister rust of white pine. U. S. Dept. Agr., Bur. Plant Indus. Bul. 206, p. 36. 1911.

[3] Spaulding, Perley. Notes on Cronartium comptoniae. *In* Phytopathology, v. 3, no. 1, p. 62. 1913.

not so much in the total number of diseased trees present as it does instances that the writer has had an opportunity to investigate personally and where the origin of the spores has been determined. Two instances, on the other hand, where no diseased pines were found, seem to indicate that the æciospores were blown long distances, though this is by no means a certainty. In the three instances examined by the writer in 1913, the Ribes were about 100 feet from the diseased pines. There is every reason to believe that the uredospores of the white-pine blister rust may be blown half a mile or more.[1]

GENERAL RESULTS OF INSPECTIONS.

Some of the general results of the annual inspections made for the white-pine blister rust, beginning in 1909 and continued to the present time, are of interest. In the States north and east of Washington, D. C., about 4,000,000 white pines are known to have been imported since 1900. Probably 500,000 more have been privately imported, about which nothing is known, making a total of about 4,500,000 trees imported into these States. Of this number 1,725,000 are known to have been destroyed before they reached the hands of private individuals, leaving 2,775,000 which have been set out in lots ranging from 500 to several hundred thousand trees. The number of such known lots is approximately 200. The inspection of these trees has varied much, some having been inspected once, some carefully inspected for the first time in 1913, and still others carefully inspected each year since the discovery of the disease on pines in this country in 1909. The figures given in Table I cover only those plantations that have been continuously under inspection from the beginning.

TABLE I.—*Results of the continuous inspection of infected lots of white-pine trees.*

No.	Item.	Number.
1	Total trees inspected	910,000
2	Total trees found diseased	8,177
3	Total trees found with fruiting bodies of the fungus (data available for but 560,000 trees)	938
4	Lots of trees inspected	150
5	Lots of trees where disease was found	88
6	Lots of trees where fruiting bodies of the fungus were found	45

In Table I, item 6 includes none of the lots counted in item 5, and the same is true of items 2 and 3. The same is also true of similar items in Table II.

In considering these results it must be remembered that a single tree with fruiting bodies of the fungus and in proximity to a currant bush may start an epidemic of the disease which may continue for years and may spread over an area of several square miles. In fact, this is practically what happened at Geneva, N. Y. The danger lies

[1] Stewart, F. C., and Rankin, W. H. Cronartium ribicola and the proscription of Ribes nigrum. (Abstract.) *In* Phytopathology, v. 3, no. 1, p. 73. 1913.

in their wideness of distribution. The fact that 938 trees bearing fruiting bodies of the fungus were found within a certain area is of no special significance unless we note that they were found in about thirty different localities which are scattered well over that entire area of thousands of square miles. Then we perceive that it is inevitable that the disease will become established in one or more of those localities unless efficient control measures are taken and faithfully continued until the disease is eradicated. As already indicated, this is not being done everywhere.

TABLE II.—*Results of inspections of 80 lots of infected white-pine trees.*

No.	Item.	Lots.
1	Trees found bearing fruiting bodies in 1910 and not afterwards	15
2	Trees found bearing fruiting bodies in 1911 and not in 1910 or 1912	3
3	Trees found bearing fruiting bodies one year and also each year afterwards	3
4	Trees bearing fruiting bodies not found at first, but which were discovered later	5
5	Diseased trees found at first, but not in later years	21
6	Diseased trees found continuously	12
7	Diseased trees found irregularly (does not include those in item 5)	10

Items 1 and 2 show that in one-fifth of the lots the inspector apparently removed all the trees bearing fruiting bodies of the fungus in a single year, but in every such case trees were found thereafter which were diseased, but did not bear the spores of the fungus. In a single instance only, all of the diseased trees were apparently removed by the first inspection. Our experience to date decidedly discourages the idea that a single inspection is efficient in eradicating this disease. Item 5 apparently contradicts this statement, but these lots may easily have been cases where the inspector took everything showing any abnormality and reported it as suspicious, when the disease was really absent.

In a previous paper [1] the writer mentioned the apparent effect of cool weather in regulating the formation of telia of *Cronartium ribicola* in the greenhouse at Washington. This experience has been repeated the present season. Apparently, farther north, where the nights are relatively cool, this inhibition does not occur, as telia were found in northern Vermont on July 23.

In a recent publication,[2] which received limited distribution, the writer showed the inefficiency of inspection, except as a temporary expedient, in trying to eradicate this disease. The total destruction of infected lots of white pines was urged as being the only safe course. This means a considerable present loss, which, however, will be very slight when compared with the loss that will result if the blister rust is allowed to become established and to spread.

[1] Spaulding, Perley. Notes upon Cronartium ribicola. *In* Science, n. s., v. 35, no. 891, p. 146–147. 1912.

[2] Spaulding, Perley. The present status of the white-pine blister rust. *In* U. S. Dept. Agr., Bur. Plant Indus. Circ. 129, p. 9–20, 6 fig. 1913.

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